



University
of Glasgow

Combined RHESSI & Hinode(XRT) (Micro)Flare Observations

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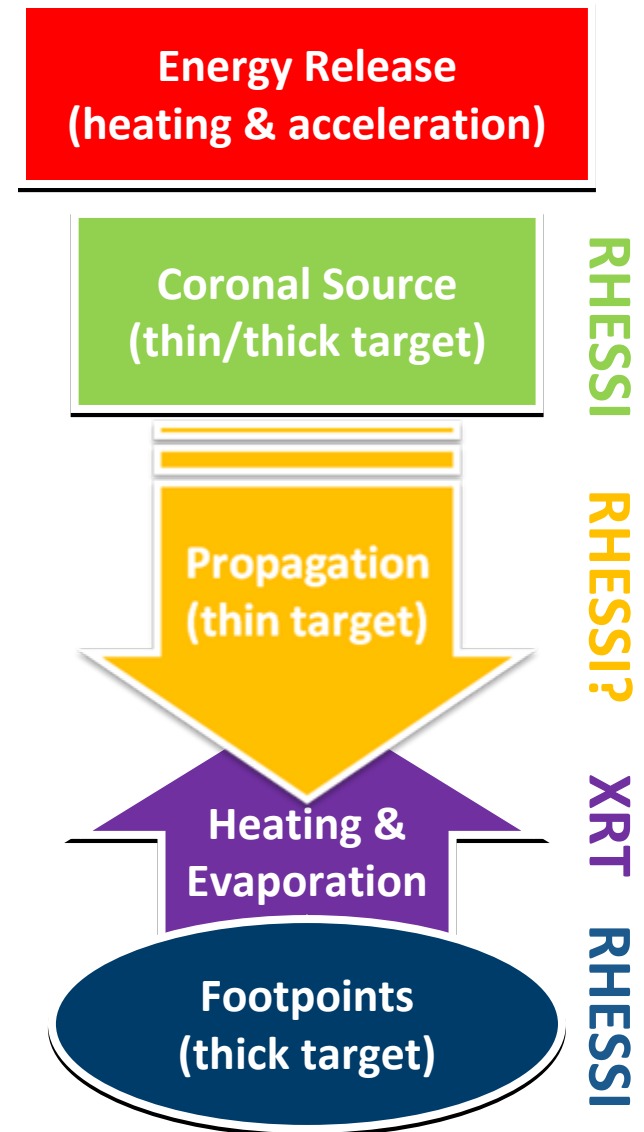


Science & Technology
Facilities Council

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- **Investigate particle heating and acceleration in active region microflares (small A,B-Class flares) via X-ray observations**
 - RHESSI and Hinode/XRT
- **Detailed analysis in a few events (with multi-wavelength) leading to statistical survey of many events**
 - Insights into the “standard model”
 - Many microflares to work with
- **Details of previous combined observations**
 - But degraded performance with pre-anneal RHESSI
- **New Microflare Observations**
 - December 2007 microflares from AR10978
 - Post-anneal RHESSI

- **Aspects of Standard Model**
 - Energy Release
 - Energy Transport
 - Emission Mechanism
- **Need not be separate or independent processes**
- **RHESSI provides information about the accelerated particles & high temperature emission**
- **XRT provides information about the dynamical thermal response to these particles.**

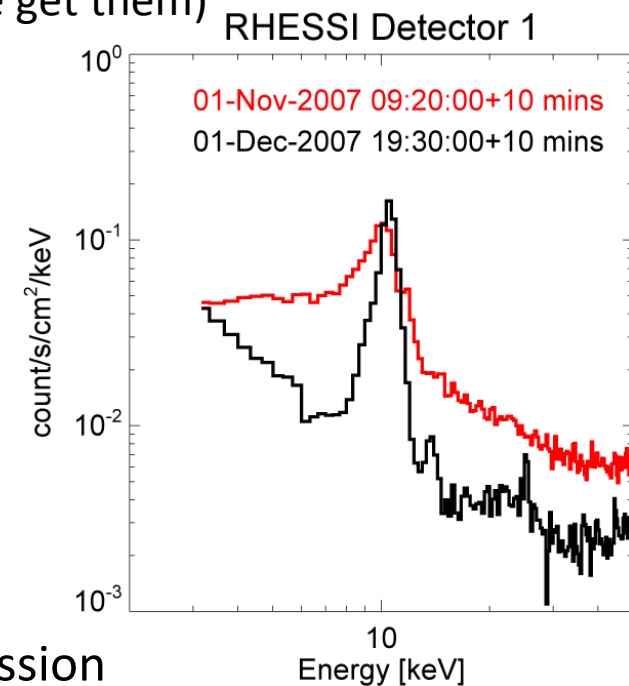


Hinode/XRT

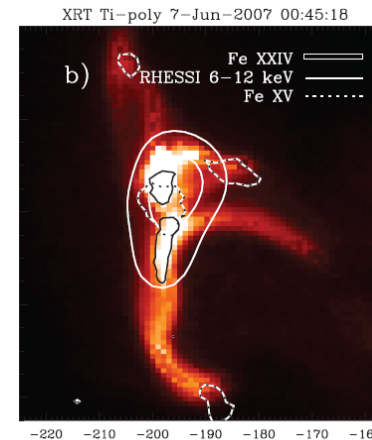
- Direct soft X-ray imaging, with high sensitivity & resolution
- Dynamics and thermal response to accelerated particles
- **Challenges: Can be saturated during the bright impulsive phase**
 - Issue for microflares, far worse for M/X-class (if we get them)

RHESSI

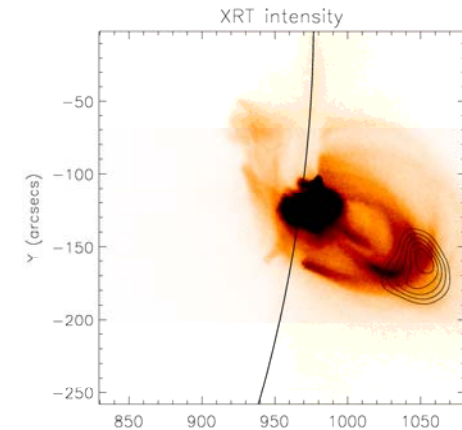
- Imaging & Spectral Analysis > 3keV
- Characteristics of accelerated and heated particles from non-thermal & thermal X-ray emission
- **Challenges: Degraded performance '06, '07 due to radiation damage, fixed Nov'07**
 - Higher than expected temperature
 - Higher background can hide non-thermal emission



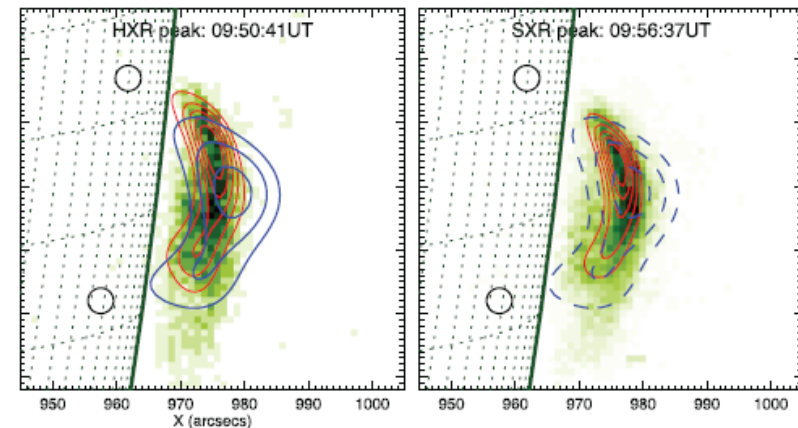
- **Some events where coronal energy release predominantly heating not acceleration**
 - Bone et al. 2008 (ASPC 397)
 - Milligan 2007 (ApJL 680)
- **Non-thermal loop emission not thin target**
 - Krucker et al. 2007 (ApJL 671)
[Sam's talk at 11:00]
- **Lack of Neupert Effect**
 - McCaughey et al. (Poster P9-6)
 - Hannah et al. 2008 (A&A 481)
 - Next slide



Milligan



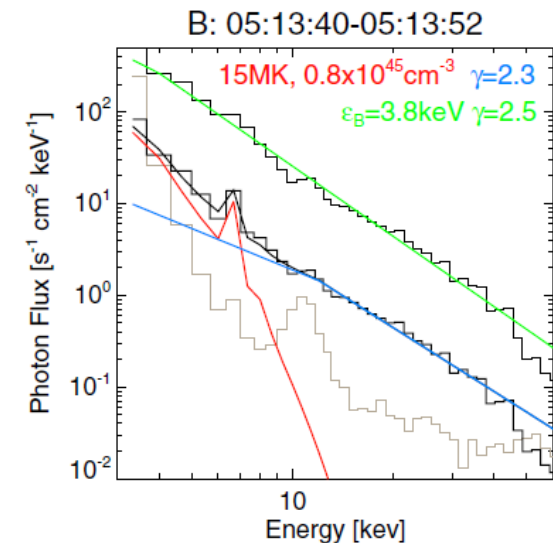
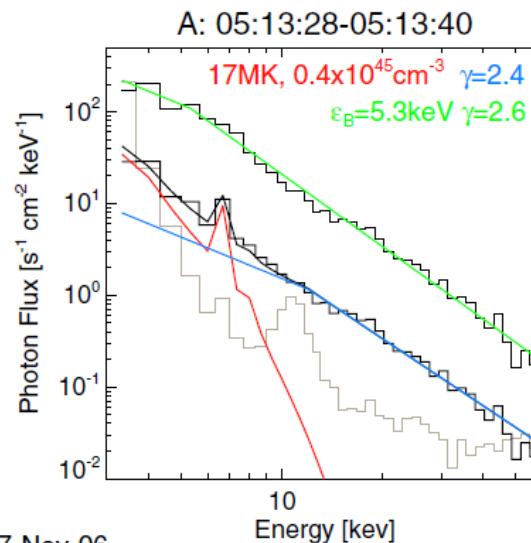
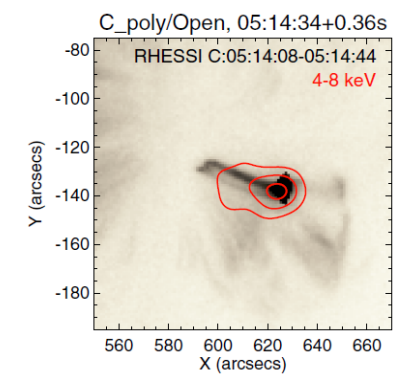
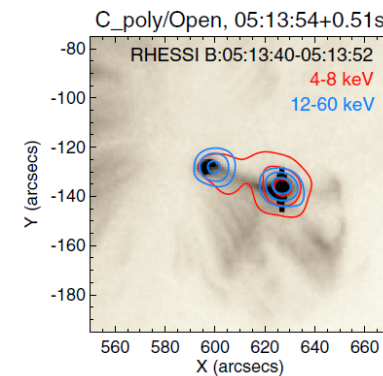
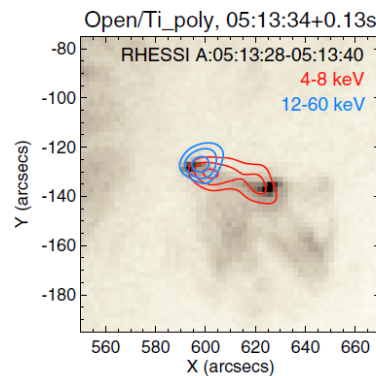
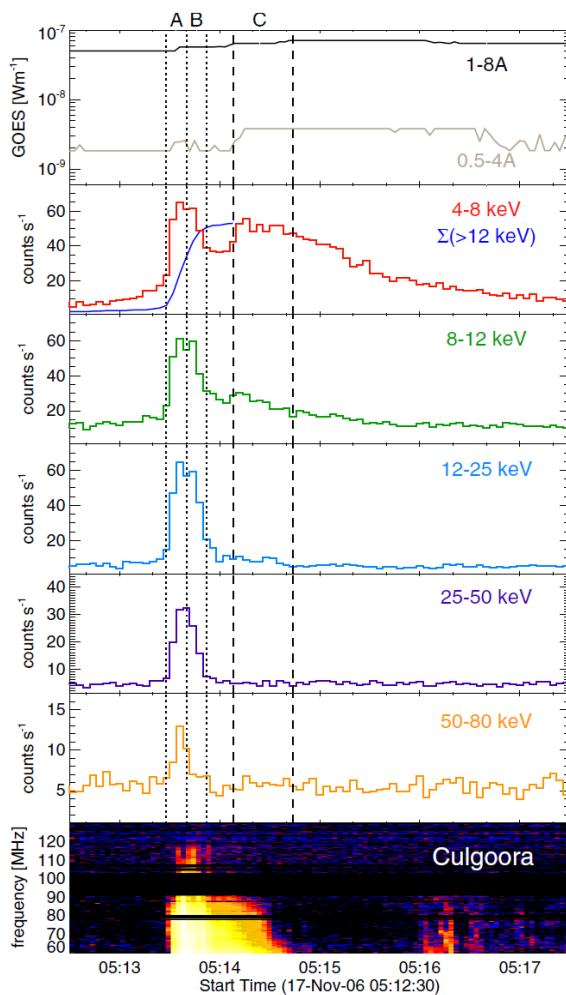
Bone



Krucker

- **Hannah et al. 2008 (A&A 481)**

- Unusual microflare with hard spectrum to high >50 keV and possibly low 4 keV energies. Clear HXR footpoints matching XRT, TRACE & violation of Neupert Effect

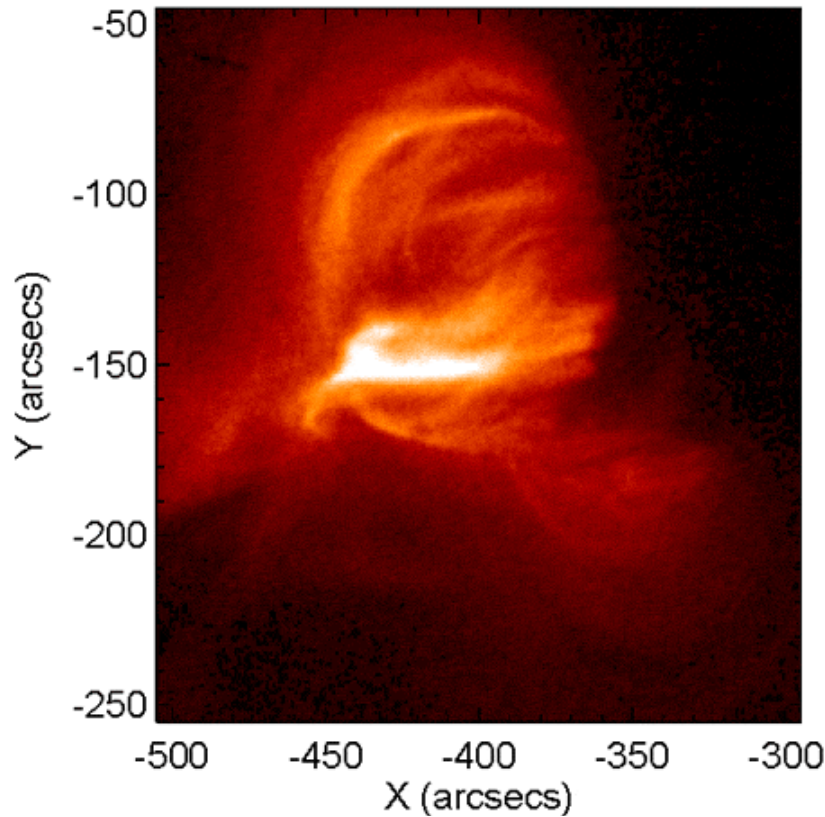


17-Nov-06

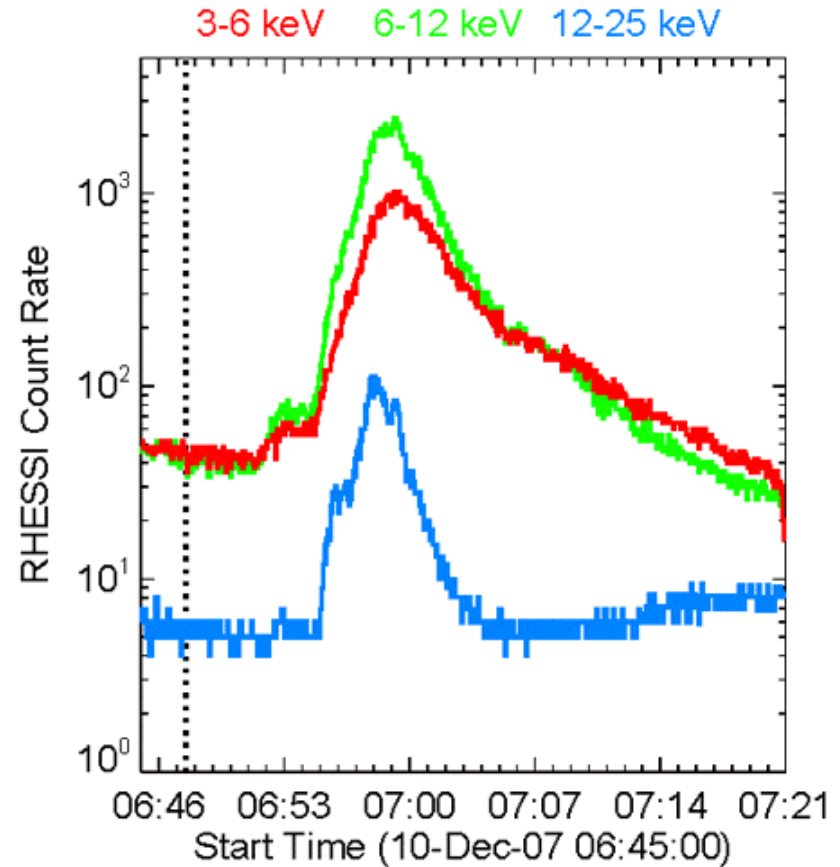
- **Previous RHESSI & Hinode flare observations were not helped by RHESSI's pre-anneal performance**
 - This has made analysis difficult
 - Produced uncertainties in interpreting results
 - i.e. Could not determine low energy cut-off of accelerated electrons in Hannah et al. 2008 (A&A)
- **New RHESSI & Hinode microflare observations post Nov'07**
 - 3 events from AR10978, December 2007
 - 10-Dec-2007 07:00 GOES B7
 - 10-Dec-2007 08:10 GOES B4
 - 10-Dec-2007 11:36 GOES B3.5
 - Many microflares with good RHESSI coverage and sometimes multiple filter observations with Hinode/XRT from this AR
 - Work in Progress.....

- Heating in nearby/flaring loop before impulsive phase?

XRT: C_poly/Open, 06:47:32 +0.18sec

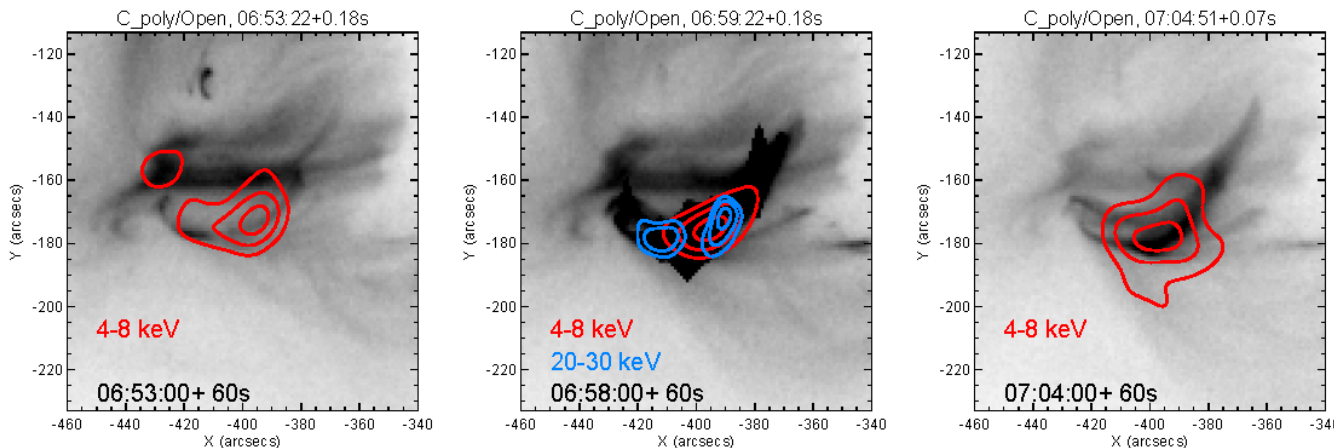
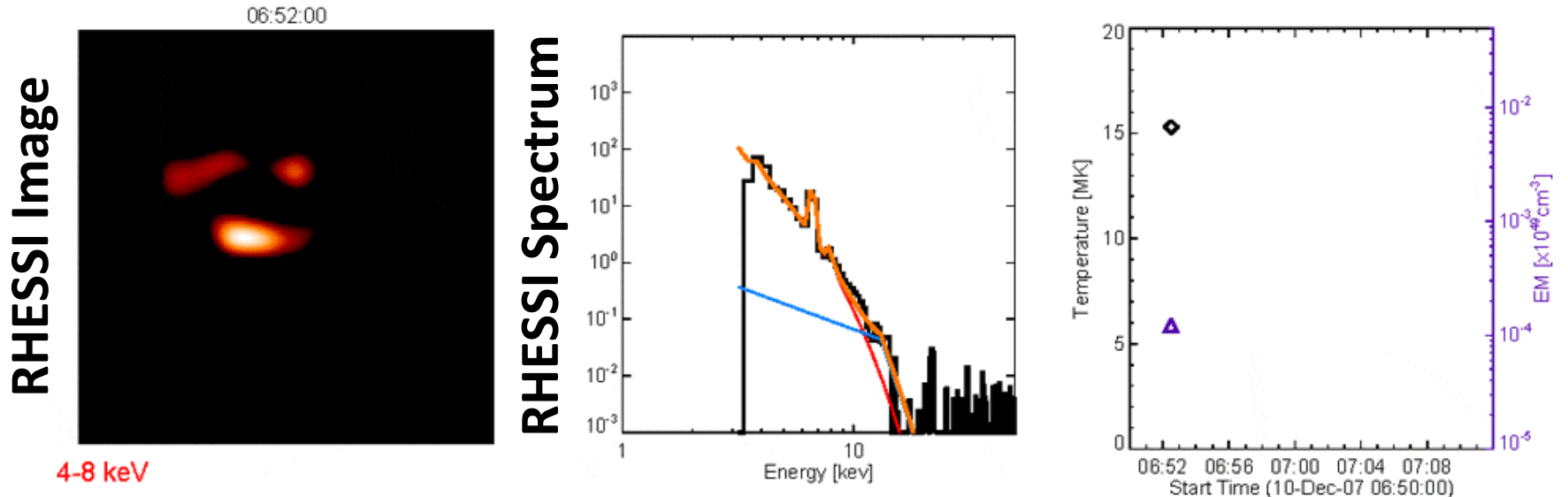


XRT MOVIE



RHESSI Lightcurve

- Detailed RHESSI Images and spectral fitting
 - Temperature and Emission Measure from spectral fit



XRT IMAGES

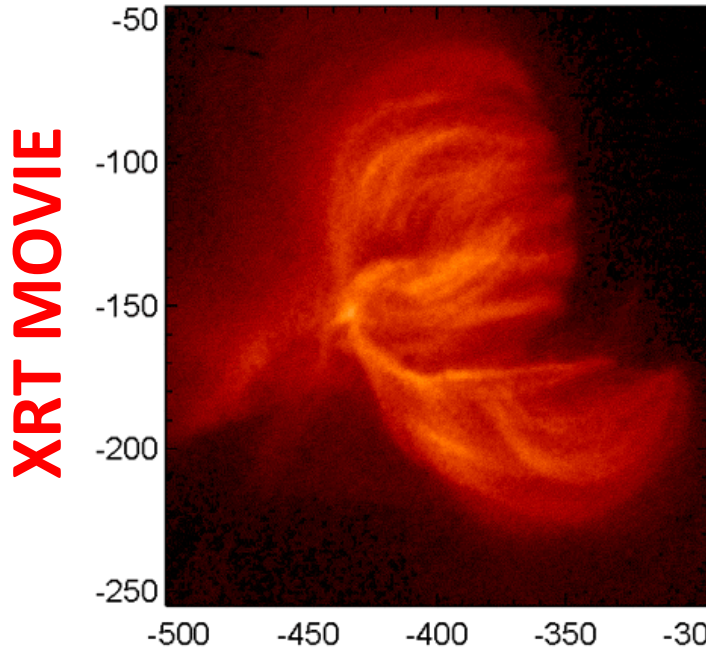
x,y shift to match RHESSI

RHESSI 4-8keV

RHESSI 12-20keV

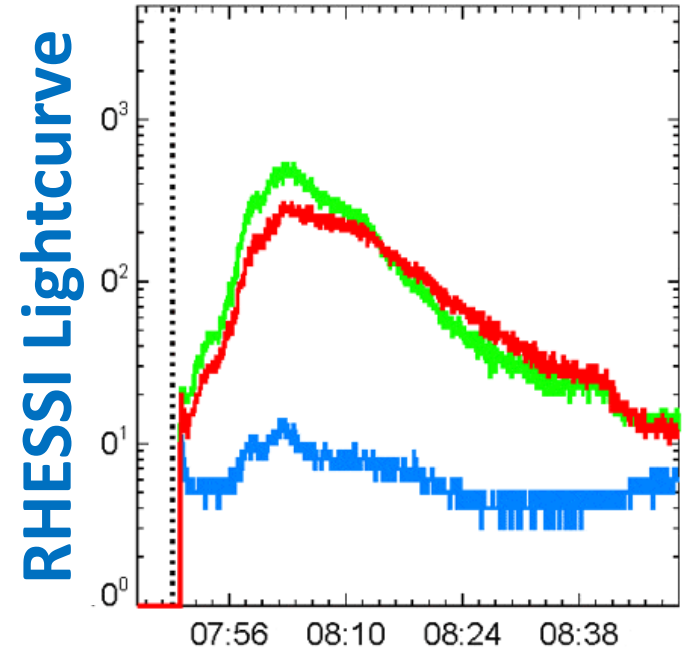
- Long Duration, gradual event, small amount of non-thermal

XRT: C_poly/Open, 07:49:12 +0.18sec

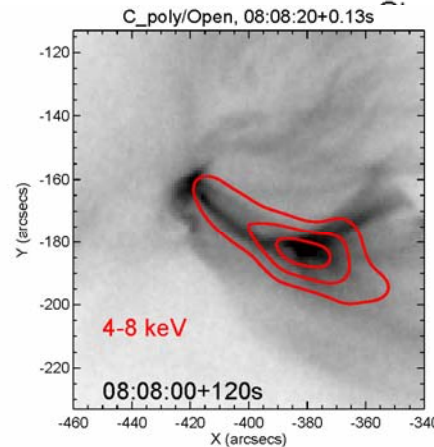
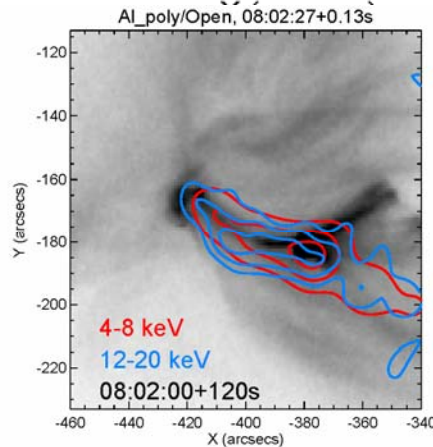
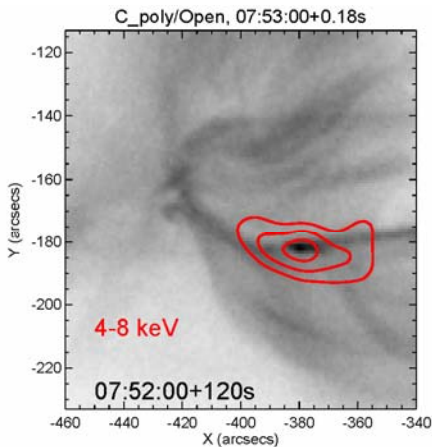


XRT MOVIE

3-6 keV 6-12 keV 12-25 keV



RHessi Lightcurve



Time (10-Dec-07 07:45:00)

XRT IMAGES

x,y shift to match RHessi

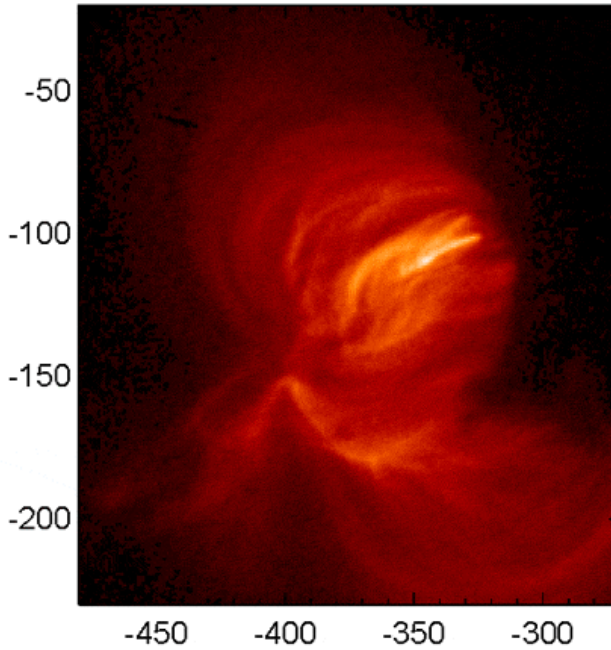
RHessi 4-8keV

RHessi 12-20keV

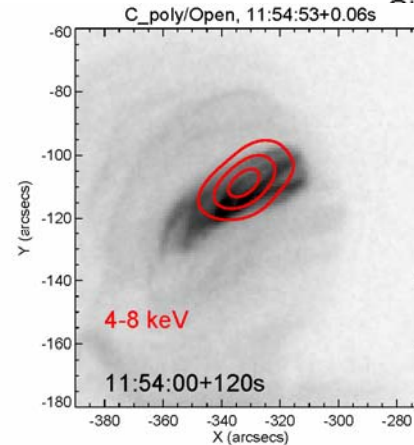
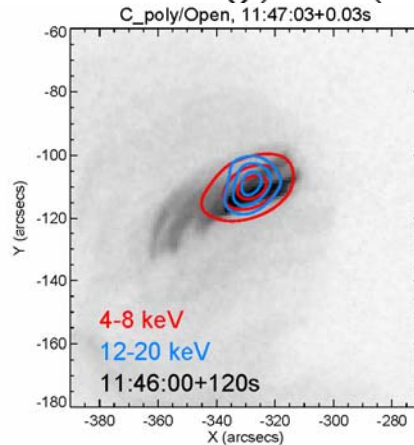
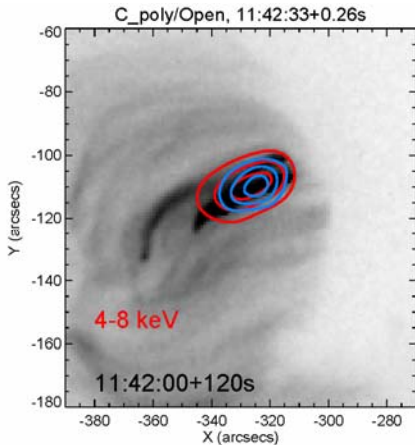
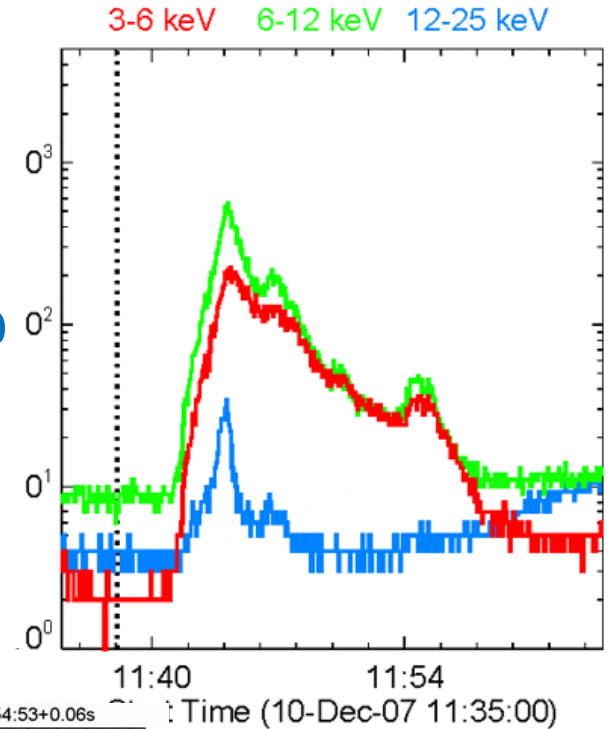
- Impulsive HXR emission, multiple hot loops

XRT: C_poly/Open, 11:38:03 +0.26sec

XRT MOVIE



RHESSI Lightcurve



XRT IMAGES

x,y shift to match RHESSI

RHESSI 4-8keV

RHESSI 12-20keV

- **RHESSI and Hinode observations provide interesting insights that challenge the standard flare model, i.e.**
 - Why is the coronal energy release heating or acceleration dominated in some events
- **Ideally need to do statistical survey of detailed SXR and HXR microflare properties**
 - Easier post-anneal (Nov'07) but not many events
 - Many events pre-anneal but analysis challenges
- **New opportunities with (hopefully) forthcoming events from Cycle 24 and new missions like SDO.**